WHAT IS CLAIMED IS:

1. A molecular rotary nanomotor comprising, as structural components:

    a gp10 connector protein;

    a gp8 capsid protein; and

    a non-naturally occurring pRNA;

wherein the structural components are associated with one another to form a nanoscale structure that effects translocation of a polynucleotide in the presence of a gp16 protein, ATP and Mg^{++}.

2. The molecular nanomotor of claim 1 wherein the non-naturally occurring pRNA is one that folds into a structure similar to that of naturally occurring phi29 pRNA (SEQ ID NO: 2).

3. The molecular nanomotor of claim 1 further comprising a protein gp7.

4. The molecular nanomotor of claim 1 wherein the translocation activity can be reversibly stopped by contacting the nanomotor with a metal chelating agent, contacting the nanomotor with a nonhydrolyzable ATP analogue, or depriving the nanomotor of a source of gp16 protein, ATP or Mg^{++}.

5. An isolated molecular nanomotor comprising as structural components:

    a connector protein;

    a capsid protein; and

    a pRNA;

    wherein the structural components are associated with one another to form a nanoscale structure that effects translocation of a polynucleotide in the presence of ATP and Mg^{++}, and wherein the pRNA binds ATP and drives the rotational motion of the nanomotor.

6. The isolated molecular nanomotor of claim 5 wherein the pRNA is selected from the group consisting of SF5 pRNA (SEQ ID NO: 5), B103 pRNA (SEQ ID NO: 6), M2/NF pRNA (SEQ ID NO: 7) and GA1 pRNA (SEQ ID NO: 8).

7. The isolated molecular nanomotor of claim 5 wherein the pRNA folds into a structure similar to that of naturally occurring pRNA from SF5, B103, M2/NF or GA1.

8. The isolated molecular nanometer of claim 5 wherein the pRNA is a non-naturally occurring pRNA.

9. A method for translocating a polynucleotide comprising:

providing a molecular nanomotor having a nanoscale structure according to any of claims 1-8; and

contacting the nanoscale structure with a gp16 protein, ATP and Mg^{++} under conditions to translocate the polynucleotide.

10. The method of claim 9 wherein the contacting step further comprises contacting the nanoscale structure with polyethylene glycol.

11. The method of claim 9 further comprising contacting the nanoscale structure with a chelating agent or a nonhydrolyzable ATP analogue to reversibly stop translocation of the polynucleotide.

12. The method of claim 11 wherein the chelating agent is EDTA.

13. The method of claim 11 wherein the nonhydrolyzable ATP analogue is γ-S-ATP.